

ART. III.—*The Distribution of Anopheline Mosquitoes in the Australian Region, with Notes on some Culicine Species.*

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(With Plates V.-IX.)

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The tribe *Anophelini* comprises one of the two principal divisions of the sub-family *Culicinae*, and is represented throughout the tropical and temperate regions of the world by numerous species, some, but not all, of which are capable of transmitting malaria. A knowledge of the distribution and habits of the various species existing in Australia and New Guinea is, therefore, of practical value in, if not an essential preliminary to, effective anti-malaria measures. A study of the literature on the subject and a personal investigation of conditions in the field, as well as a critical examination of a large number of specimens from various localities, convince the writer that our knowledge is totally inadequate to a thorough scientific study of the distribution of the disease, its disseminators and its eradication or reduction.

It is 26 years since Grassi discovered that malaria is conveyed from infected to non-infected persons by anopheline mosquitoes, yet the species of carrier or carriers is still unknown in Australia. Maplestone (1923) says: "The statement by Harrison (1922) is an accurate summary of the present state of our knowledge in this respect, when he says that there is evidence that the local *Anopheles* are capable of acting as intermediate hosts for the malaria parasite." Harrison's statement still summarises the position. *Anopheles annulipes* Walker is generally hypotheticated for Australia, but Maplestone considers that *A. bancrofti* Giles has more to do with malaria than has hitherto been supposed. References to *Anopheles* in North-West Australia are few and, for the reason given below, indefinite, notwithstanding the fact that in certain localities malaria is endemic. The breeding places of *A. annulipes* have been described in some detail (Hill, 1922), but as a result of more recent research this information must now be regarded as applying more especially to related forms of doubtful status.

In Papua, also, where malaria is endemic, the carrier or carriers is undetermined and anti-anopheles measures have been confined to the more obvious surface accumulations of water in ignorance of the fact that native canoes and seepage are sources

of an abundant supply of potential, if not actual, carriers of two species, one of which has not hitherto been recorded from the Australian region. In New Britain, where Dr. G. M. Heydon has definitely implicated two of the three known species, knowledge of the relationship of *Anopheles* to malaria and of the breeding habits of the carriers is far more advanced than it is in Australia or Papua.

The Tribe *Culicini*, which includes the greater part of the mosquito fauna of the region, is of less importance than the Tribe *Anophelini*, but, as many of its included and little known species cannot be regarded otherwise than as potential carriers of parasitic diseases in man, a much greater knowledge than we now possess of their habits and early stages is very desirable.

In preparing this contribution to the literature on the subject the writer has followed the classification and nomenclature adopted by Edwards, whose recent paper (1924) provides students with the first authoritative list of the Australian species, with the synonyms under which many of them have remained obscured.

Anopheles of Australia.

Eight species of *Anopheles* have been recorded from Australia, namely:—*A. corethroides* Theo. (S. Queensland), *A. atratipes* Skuse (S. Queensland and New South Wales), *A. stigmaticus* Skuse (New South Wales), *A. bancrofti* Giles (Queensland and Northern Territory), *A. annulipes* Walker (Tasmania and Australia generally), *A. musicus* Skuse (New South Wales), *A. mastersi* Skuse (New South Wales), and *A. amictus* Edwards (N. Queensland and N. Territory). *A. corethroides* is synonymous with *A. stigmaticus*, while the latter and *A. atratipes*, two well-defined and rare species, are negligible as disseminators of malaria, and need not be referred to again in this paper.

A. bancrofti is considered by Edwards (1924) to be almost certainly specifically distinct from *A. barbirostris* v. d. Wulp. In the absence of males from the Oriental region the writer has been unable to make a comparison between the New Guinea and Indian forms, but it can be stated definitely that no distinction exists in either sex between specimens from Queensland, Northern Territory, Banks Is. (Torres Strait), Madang (New Guinea), and Admiralty Islands. The most obvious distinction in the females is stated by Edwards to be in the presence of numerous more or less scattered pale scales on the femora and tibiae of *A. bancrofti*. These are certainly present in all the Australian and New Guinea specimens the writer has examined, as well as in an Indian specimen determined by Christophers. Theobald, Christophers and recent Dutch writers, on the other hand, refer New Guinea specimens to *A. barbirostris*, a proved carrier of malaria in various parts of the Malay Archipelago.

The remaining four species, namely, *A. annulipes*, *A. musicus*, *A. mastersi* and *A. amictus*, are all closely allied to each other, and

constitute a well-defined and widely distributed group (Sub-genus *Myzomyia*), characterised by boldly marked wings and spotted legs. The validity of three of the four species has been questioned by different writers. The group is an important one and, since it probably includes the principal carrier or carriers of malaria in Australia, it is desirable that the status of these related forms, and several others as yet undescribed, should be definitely determined. Some may be carriers of malaria, others not. A satisfactory definition of these species, varieties or races—which ever they may prove to be—and their geographical distribution might offer a more acceptable explanation of the remarkable distribution of malaria in Australia than has been advanced hitherto. With the object of throwing some light on the subject the writer examined all the available material (over 400 adults) collected by him since the early part of 1911 in various localities, and, in addition, several small collections from South-West Australia, South Queensland and Tasmania. The results, so far as the above-mentioned species are concerned, are not conclusive, but they show that two described and one undescribed form from North Australia must now be added to the list of possible carriers.

The differences between some of these forms are hardly appreciable; in others they are sufficiently well marked to appear to warrant their recognition, for the time being at any rate, as distinct varieties, if not species. Difficulties arise, however, in deciding the dividing line owing to the occurrence of intermediates. The following observations refer to females only, unless the contrary is stated.

A comparison between two specimens from Tasmania, 54 from Victoria, 28 from South-West Australia, and 90 from South Queensland shows that each series contains individuals of both sexes identical with each other in every respect. In one unimportant detail (the absence of basal bands on the tarsal joints) most of them differ from the typical *annulipes* from Tasmania, but there can be no doubt that they are referable to this species. The South-West Australian and Queensland series contain, also, several variations from the above, differing only in the presence or absence of certain bands on the legs and scales on some of the body segments. Specimens from New South Wales have not been examined, but there is no doubt in the writer's mind that both of the described species from that locality (*musivus* and *mastersi*) are identical.

Townsville (N.Q.) specimens of both sexes can be separated readily into three groups on the colour of the proboscis and legs, and on the nature of the scales on the abdomen. Some individuals in one group ("A") cannot be distinguished from specimens from southern Australia, and are unhesitatingly referred to Walker's species (*annulipes*); the other two ("B" and "C") contain specimens of approximately the same size, but more yellow in colour. Slight variations occur in each group,

some of which show evidence of close relationship between all three. Breeding experiments designed to determine the relationship (if any) were undertaken successfully, but, unfortunately, only the males are now available for examination. This shows clearly that typical female examples of each of these three groups do not always produce males which can be correctly assigned to the groups to which their respective female parents belonged without a knowledge of their history. Examples of all three groups have been reared repeatedly from larvae collected in the same puddles—generally hoof-holes near swamps.

The characters and distribution of these three groups are:—

"A" *A. annulipes* Walk., *A. mastersi* Skuse, *A. musivus* Skuse (Fig. 1 a-f). Proboscis with apical half testaceous, with or without dark scales near the labellum, these rarely extending over the entire apical $1/5$, proboscis sometimes entirely dark scaled (three specimens captured in Melbourne in mid-winter); tarsi with apical bands, rarely with basal bands on joints 2-4 of fore-legs; spots on femora and tibiae variable in size; abdomen with scanty long pale scales on segments 2-7, increasing in number progressively from the second, 8th segment and cerci more or less covered with white scales, or frequently with only two or three pale scales on segments 2-7, or, rarely, with more numerous scales (but noticeably less than in "B"), mostly pale yellow in colour. Distribution: Tasmania, Southern Australia generally, Queensland, (Brisbane, Townsville, Cairns), Central Australia (Charlotte Waters, Alice Springs).

"B" *A. amictus* Edw. (Fig. 2 a-f). Proboscis entirely dark; tarsi with apical bands only, leg spots variable; abdomen rather densely clothed with short broad, mostly yellow, scales, with a patch of dark (lead) ones in the middle of segments 4-6, or on the greater part of segments 2-6, or, occasionally, reduced to a few on each of the median segments. There can be no doubt that this is the species described by Edwards; the description of the wings, however, does not agree, since the first longitudinal vein almost invariably bears long spots, a character of no importance because hardly two individuals are marked alike, and differences often occur in wings of the same insect. Distribution: North Queensland (Townsville, Palm Island), Northern Territory (Darwin).

"C" *A. (?) amictus* Edw. (Fig. 3 a-f). Proboscis entirely dark; tarsi apically and basally banded; abdomen rather densely clothed with golden scales rather longer and narrower than those in *amictus*, very rarely a few dark scales on middle of segments 4-6. Several examples (from Darwin) have much wider tarsal bands, 4th tarsi entirely white and abdomen as in typical *amictus*.

The egg measures 0.530 mm. in length, and has a maximum width (exclusive of the floats) of 0.215; otherwise it is similar to that of *A. punctulatus* var. *moluccensis* (Swell.), which is only 0.480 mm. in length.

Of 100 females from Townsville 25 are referred to group "B" (*A. amictus*); 1 to group "C," and 42 to group "A" (*A. annulipes*); but among the 42 are 7 specimens that are known definitely to be the progeny of typical females of *amictus*, and 5 of typical females of group "C."

The male genitalia have not been compared.

In addition to the forms referred to above, *A. punctulatus* var. *moluccensis* (Swell.) occurs commonly in various localities between Port Darwin and the Katherine River, Northern Territory, whilst a single example (female) from Borroloola, N.T., is identical with *A. punctulatus* Don. Both have been demonstrated as carriers of malaria in New Britain.

A general survey of the material referred to above shows that the southern specimens of *A. annulipes* are usually larger and more vividly coloured (black and white) than those from Northern localities, but the South Queensland and some of the Northern Territory specimens occupy an intermediate position as regards colour, and are of the maximum size.

For practical purposes, and especially to facilitate recording infection experiments with malaria, it may be desirable to distinguish by varietal names some of the above, but it appears to be otherwise undesirable to burden the literature with additional names until decisive experiments have been carried out.

The examination of numerous larvae from Townsville, New Guinea, and New Britain show that they vary considerably, and cannot be relied upon to differentiate the closely allied forms found there.

Anopheles of New Guinea, New Britain and adjacent Islands.

The following species or varieties of *Anopheles* have been recorded from New Guinea, New Britain and adjacent islands:—

Bironella gracilis Theobald (North-West New Guinea).

Stethomyia aitkeni var. *papuae* Swellengrebel (North-West New Guinea).

Anopheles barbirostris v. d. Wulp (New Guinea).

Anopheles umbrosus Theobald (New Guinea).

Anopheles punctulatus Donitz (New Guinea and New Britain).

Nyssorhynchus annulipes var. *moluccensis* Swell. (New Guinea).

Nyssorhynchus annulipes Walker (Papua).

An examination of the specimens recorded from Papua by Taylor as *A. annulipes* shows them to be referable to *moluccensis*.

Christophers' (Trans. 4th Congr. Far Eastern Assn. Trop. Med.) record of *A. umbrosus* from New Guinea and Australia probably refers to *A. bancrofti* Giles.

Bironella gracilis (Fig. 4 a-e) occurs also in New Britain, where the larvae were found abundantly in a small running mountain stream (tributary of the Nambung River) in the Beining District, by Heydon and the writer in 1922. The above figures supplement those of Brug and de Rook (1922). The outer clypeal hairs could not be detected in any of the New Britain specimens; those figured (detached) are copied from the Dutch authors' work.

A. punctulatus (Fig. 5 a-e) occurs in New Britain, Papua (Moresby and Mekeo Districts), Samarai and Woodlark Island. In the first-mentioned locality, where the most systematic collecting has been done, it has been reared only from temporary rain pools, roadside puddles, and such depressions as are formed by the natives and stock on muddy tracks, but it has been reared by the writer also from seepage and running grass-covered plantation drains in Samarai, and from beached native canoes near Moresby. It occurs at moderately high elevations (? 1800 feet) in New Britain (Tona and Beining Mts.).

N. annulipes var. *moluccensis* (Fig. 6 a-d) is regarded by Edwards as synonymous with *punctulatus*. It is the predominant form in New Britain and Papua (Moresby and Mekeo Districts), and the only form of *Myzomyia* the writer has seen from Madang, Admiralty Group, Solomon Group and New Ireland. It does not occur in Samarai, as far as is known. In New Britain it breeds near the sea beaches in grass-grown drains, wells and brackish swamps, where neither Heydon nor the writer have ever found Donitz's species. An examination of a long series from Australia, New Guinea and New Britain shows that *moluccensis* is more valuable in adult and larval stages than is indicated in the description and figures. The following are some of the variations noted in the adults:—2nd joint of palpi with white ring at apex, generally slightly longer than 3rd and 4th together, but often equal; labellum rarely black; abdominal tergites 1-7 without scales, or 1-3 without scales and a few on 4-7, or a few on 2-7; sternites 1-7 generally without scales, sometimes a few white ones on 8th; wing markings very variable; legs often without large spots forming incomplete rings, commonly as in Fig. 6 c and d; tarsi rarely entirely dark except for a few spots near middle of 1st hind tarsi; 4th and 5th hind tarsi commonly entirely dark. The eggs, larvae, pupae and males are apparently indistinguishable from those of *punctulatus*. The adult female *punctulatus* is distinguished by the proboscis, which is pale on the apical half, with or without a dark scaled subapical area on the ventral surface. The legs are generally much paler than those of *moluccensis*, but they are very variable and sometimes cannot be distinguished from those of the commoner form. The palpi generally have a broad white zone near the apex of the second segment, but this character is not constant. The relative length of the second palpal joint to the third and fourth is alike in the two forms.

The occurrence of *A. subpictus* Grassi¹ in Papua is recorded here for the first time from specimens bred by the writer from beached native canoes near Moresby, and from adults captured in various places in the Mekeo District. There is the strongest circumstantial evidence that it is the species responsible for an infection of benign tertian malaria contracted by the writer, and it is possibly an important factor in the transmission of the disease in that portion of the possession, where canoes have not been suspected hitherto of affording a breeding place for *Anopheles*. The larvae and pupae, which were very numerous in several canoes within easy flight of a large native village and the official residential area of Moresby, were associated with a few *A. punctulatus* and numerous *Culex sitiens* Wied. The female is readily distinguished from *punctulatus* by the following characters:—Absence of spots on the legs; 2nd joint of palpi noticeably longer than 3rd and 4th together, and entirely dark, excepting for a narrow white ring or dorsal spot at its apex; 3rd joint with a wide apical ring, and 5th entirely white.

There remains to be mentioned an unidentified species represented by larvae (Fig. 8) found in a foul pool in felled jungle in the Beining District of New Britain. It is evidently distinct from any of the species mentioned in this paper.

Notes on Culicine Mosquitoes.

Megarhinus (Toxorhynchites) inornatus Walker.

Proc. Linn. Soc., VIII., p. 102 (1865).

(Pl. VI., Fig. 9, a-d.)

This species breeds in rot-holes in trees and in tins, bottles, etc., in secluded places. The larvae are predaceous on other species.

Localities: New Britain (Rabaul and Beining Districts); Papua (Samarai).

Uranotaenia nigerrima Taylor.

Trans. Ent. Soc. 1914, p. 203 (1914).

Adults were captured in June and July in a jungle-covered ravine and on the undercut sides of wells in the vicinity of the beach.

Localities: New Britain (Rabaul and Beining Districts); Papua (Mekeo District).

Uranotaenia ? argyrotarsis Leicester.

Several specimens were found in association with *U. nigerrima* in Rabaul. It is easily distinguished, even on the wing, from

¹ Identified by Mr. Edwards from specimens forwarded to him as *A. rossi* Giles.

other local species by its white tarsi and silvery white patches of scales on the dorsum of the abdomen. Mr. Edwards, to whom specimens were referred, considers it to be too closely allied to Leicester's species to be described as new until males are available for examination.

Localities: New Britain (Rabaul); New Ireland (Kaewieng).

Uranotacnia atra Theobald.

Ann. Mus. Nat. Hung. III., p. 114 (1905).

Adults were captured on the undercut sides of an open native well.

Locality: Papua (Mekeo District).

Hodgesia spoliata Edwards.

Bull. Ent. Res. XIV. p. 8 (1923).

This species occurs, with *H. atra*, in dense jungles, and in the mangroves fringing the banks of tidal streams and estuaries. It bites freely at all times of the day.

Locality: Papua (Mekeo and Moresby Districts).

Hodgesia cairnsensis Taylor.

Proc. Linn. Soc. N.S.W., XLIII., p. 842 (1919).

Occurs in dense scrub and in the mangroves, where it is more plentiful and more troublesome than the preceding species.

Localities: New Britain (Rabaul); New Ireland (Kaewieng); Papua (Moresby District).

Hodgesia quasisanguinea Leicester.

Cul. of Malaya, p. 230 (1908).

The above, or a very closely allied species, occurs in the vicinity of Rabaul.

Locality: New Britain (Rabaul); Australia.

Rachionotomysia quasiornata Taylor.

Proc. Linn. Soc. N.S.W., XL., p. 177 (1915).

(Pl. VI., Fig. 10).

Although few specimens have been taken it is probably a common species in suitable localities, i.e., in dense jungle. It does not enter houses, and appears to be entirely diurnal and sylvan in its habits. Like many other sylvan species it is timorous, and rarely attempts to bite unless one remains almost motionless—a difficult matter in the presence of more numerous and more voracious species. Larvae were taken in rot-holes in trees in the first-mentioned locality.

Localities: New Britain (Rabaul, Toma, Beinging District); Papua (Woodlark Is., Moresby and Mekeo Districts).

Rachionotomyia filipes Walker.

Proc. Linn. Soc. V., p. 229 (1861); Taylor, Trans. Ent. Soc. 1914, p. 190 (1914), (*Stegomyia atra*).

The character by which Edwards (1924) distinguishes *atra* from this species is not constant in several specimens from Papua and New Ireland, which have the apical lateral white spots on the abdominal tergites quite as well marked as in the Northern Territory examples; the writer regards Taylor's species, therefore, as synonymous with Walker's.

Taeniorhynchus (*Coquillettidia*) *giblini* Taylor.

Trans. Ent. Soc. 1914, p. 198 (1914), (*Pseudotaeniorhynchus conopas* var. *giblini*).

Localities: Papua (Mekeo District); New Guinea (Madang).

Taeniorhynchus (*Coquillettidia*) *brevicellulus* Theobald.

Mon. Cul. 11, p. 212 (1901).

Examples (females) collected in the Mekeo District in cane-grass flats, in dense jungle, and in open scrub country agree with the less extensively purple scaled specimens in a series from New Ireland, the darkest forms of which have been identified recently as above, and, also, with the darkest forms of *T. xanthogaster* Edwards from Northern Territory. The two species appear to be impossible to separate in the absence of males.

Locality: New Ireland (Kaewieng).

Taeniorhynchus (*Mansonioides*) *uniformis* Theobald.

Mon. Cul. 11, p. 180 (1901) (*Panoplites*).

This is a very common species in Papua, especially in the Mekeo District, where, in July, it was by far the most annoying species encountered. In most of the native villages in this district mosquito-nets (made of hessian) were in evidence in many of the huts, and, upon examination, were invariably found to contain numerous engorged specimens. It is a most persistent biter, and is active throughout the day and night. The greatest numbers were found in the vicinity of weedy freshwater swamps and backwaters, but it was frequently observed in the mangroves in association with *Aedes* (*Ochlerotatus*) *vigilar* and *Aedes* (*Skusea*) *funereus*.

Localities: New Guinea (Madang); Papua (Moresby and Mekeo Districts); New Ireland (Kaewieng); Admiralty Group.

Taeniorhynchus (*Mansonioides*) *annulipes* Walker.

Proc. Linn. Soc., 1, p. 5 (1857), (*Culex*).

Specimens collected in the Mekeo District, in association with *T. uniformis* and *T. papuensis*, agree with others from New Ireland (Kaewieng), New Guinea (Madang) and Queensland.

The writer referred the latter inadvertently to *septemguttata* (*septempunctata*, a doubtful synonym of *annulipes*, was intended).

Taeniorhynchus (Mansonioides) papuensis Taylor.

Trans. Ent. Soc. 1914, p. 200 (1914).

This species has been known hitherto from the type series only; nevertheless it is common in cane-grass swamps and adjacent jungle, where it is hardly less annoying, though less abundant, than *uniformis*.

Locality: Papua (Mekeo District).

Mucidus alternans Westwood,

Ann. Soc. Ent. France, IV., p. 681 (1835).

(Pl. VI., Fig. 11 a-d.)

The figures are from North Queensland specimens. The anal papillae are variable in length, but they are generally about as long as the segment itself or half as long as the four simple hairs at its apex in specimens bred from fresh or only slightly brackish swamps.

Armigeres lacuum Edwards.

Bull. Ent. Res. XIII., p. 97 (1922).

(Pl. VI., Fig. 12 a-e.)

This is a very common species, the early stages of which are found, sometimes in great numbers, in cut-off bamboos, rot-holes in trees, and similar places. The adults are sluggish in their habits, but are capable of causing much annoyance. In the shelter of dense jungle they bite throughout the day, but do not venture from such cover until evening, when they are commonly found in dwellings and outhouses.

Localities: New Britain (coastal and mountain districts); New Ireland; New Guinea (Madang); Admiralty Group.

Armigeres ? breinli Taylor.

Trans. Ent. Soc. 1914, p. 186 (1914) (*Neosquamomyia*).

Several specimens (female) were reared from larvae and pupae collected in a rot-hole in a tree; others were captured whilst biting in the jungle. Taylor, as recorded by Edwards (1924), has confused two species under this name.

Locality: Papua (Mekeo District).

Aedes (Stegomyia) variegatus Doleschall.

Nat. Tijds. Ned. Ind., XVII., p. 77 (1858). (*Culex*).

(Pl. VII., Fig. 13 a-d.)

This mosquito is widely distributed, and very abundant in many localities. It is found commonly in houses and native huts, and

almost as commonly in the jungle. It appears to be more markedly diurnal in its feeding habits than is *argenteus*. The principal breeding places are in half cocoanuts, rot-holes in trees, wells in native gardens and villages and in beached canoes.

Localities: New Britain (Rabaul and Beining Districts); New Ireland (Kaewieng); Admiralty Group; Papua (Samarai, Kaile, Moresby, Boira, Yule Is., Waima); New Guinea (Madang).

Aedes (Stegomyia) argenteus Poiret.

(*Stegomyia fasciata*)

Locality: New Britain; New Ireland; Solomon Group.

Aedes (Stegomyia) albolincatus Theobald.

(Pl. VII., Fig. 14.)

Specimens received from Drs. Heydon and Wallace have been identified as above by Mr. Edwards.

Localities: Russell Group; New Ireland (Kaewieng).

Aedes (Stegomyia) albopictus Skuse.

Ind. Mus. Notes III., p. 5 (1895) (*Culex*).

Localities: Papua (Mekeo and Moresby Districts); Islands of Torres Strait; Australia (Darwin).

Aedes (Aedimorphus) alboscuteatus Theobald.

Ann. Mus. Nat. Hung. III., p. 80 (1905) (*Lepidotomyia*).

Localities: Papua (Mekeo District and Woodlark Is.).

Aedes (Ochlerotatus) vittiger Skuse.

Proc. Linn. Soc. N.S.W. (2) III., p. 1728 (1889) (*Culex*).

(Pl. VII., Fig. 15 a-g.)

Localities: Queensland; New South Wales.

Aedes (Ochlerotatus) vandema Strickland.

Entom. XLIV., p. 202 (1911) (*Culicada*).

This appears to be a rather common species in the vicinity of the foothills of the Dandenong Ranges, Vic., where it is associated with *Aedes (O.) camptorhynchus* (Thoms.) and *Theobaldia frenchi* (Theo.).

Aedes (Ochlerotatus) vigilax Skuse.

Proc. Linn. Soc. N.S.W. (2) III., p. 1731 (1889) (*Culex*).

(Pl. VII., Fig. 16 a-c.)

The fact that this species occasionally breeds in fresh water has been recorded in an earlier paper (Hill, 1922); such larvae have longer and narrower anal papillae than those bred under more normal conditions. A similar change takes place in *Mucidus*

alternans, but apparently not in *Culex sitiens*, both of which breed in fresh or salt water.

Localities: Australia; Papua.

Aedes (Finlaya) kocki Dönitz.

Insekten Borse, V., p. 38 (1901) (*Culex*).

Although generally found as a sylvan species, it frequently enters houses. Larvae were taken in half cocoanuts on many occasions. The pale markings on the wings and legs are generally tinged with yellow, but are often pure white.

Localities: New Britain; New Ireland; Woodlark Island; Papua (Waima and Yule Island).

Aedes (Finlaya) milsoni Taylor.

Proc. Linn. Soc. N.S.W. XL., p. 179 (1915) (*Culicada*).

This species has been reared from larvae and pupae taken in a rot-hole in a tree, Gembrook District, Victoria (G.F.H., May, 1924).

Aedes (Finlaya) notoscriptus Skuse.

Proc. Linn. Soc. N.S.W. (2), III., p. 1738 (1889) (*Culex*).

(Pl. VII., Fig. 17.)

Localities: New Britain; New Ireland; Admiralty Group.

Aedes (Finlaya) quasirubrithorax Theobald.

Mon. Cul. V., p. 348 (1908) (*Culex*).

(Pl. VIII., Fig. 18 a-d.)

The figures are drawn from specimens found in a rot-hole in a tree.

Locality: Queensland (Townsville).

Aedes (Macleaya) tremula Theobald.

Entom. XXXVI., p. 154 (1903).

(Pl. VIII., Fig. 19 a-c.)

The figures are drawn from Queensland specimens.

Aedes (Pseudoskusea ?) culciformis Theobald.

Ann. Mus. Nat. Hung., III., p. 77 (1905) (*Skusea*).

Localities: New Britain; New Ireland; New Guinea; Papua (Mekeo District).

Aedes (Pseudoskusea) concolor Taylor.

Trans. Ent. Soc. 1913, p. 1700 (1914) (*Caenocephalus*).

Locality: Victoria (Coode Is.).

Aedes (Aedes) funereus Theobald.

Mon., Cul. III., p. 292 (1903) (*Skusea*).

(Pl. VIII., Fig. 20.)

A common and troublesome species in many coastal localities, especially in the vicinity of mangroves and adjacent scrub.

Localities: New Britain; New Ireland; New Guinea; Papua.

Aedes (Aedes) funereus, var. *rnatus* Theobald.

Ann. Mus. Nat. Hung. III., p. 79 (1905) (*Skusea*).

One of the commonest and most troublesome jungle-frequenting species in both coastal and inland localities. It is diurnal and nocturnal in its feeding habits, but does not enter houses. It breeds in grass-covered plantation drains.

Localities: New Britain; New Ireland; Admiralty Group; Papua.

Lutzia halifaxi Theobald.

Mon., Cul. III., 6, 231 (1903).

(Pl. VIII., Fig. 21 a-d.)

Adults were reared from grossly contaminated wells in Rabaul and Mekeo Districts; in the former locality in association with *Culex (Culiciomyia) muticus* Edw., and in the latter with *Culex sitiens* W. They are somewhat smaller and darker than Australian specimens, but no differences have been detected in larvae, pupae or adults to warrant their recognition as a distinct variety.

Culex fatigans Wiedemann.

Aussereur. Zweifl. Ins. I., p. 10 (1828).

The apparent scarcity of this species, as well as *Aedes (Stegomyia) argenteus*, in Samarai and Rabaul is probably due to the efficiency of anti-mosquito measures. A dark variety occurs commonly with the typical form in the undermentioned localities.

Localities: New Britain; New Ireland; New Guinea (Madang); Papua (Moresby, Yule Is., and Samarai).

Culex sitiens Wiedemann.

Aussereur. Zweifl. Ins. I., p. 543 (1828).

(Pl. VIII., Fig. 22 a-c.)

In the vicinity of Rabaul immense numbers of larvae and pupae were found in a small fresh-water pool in the sandy soil near the beach, not far from which the adults were very troublesome. Adults were frequently taken at the hospital, which is situated on the heights overlooking the town. It occurs in all the Papuan villages visited by the writer, and is especially abundant in the Mekeo District. Although larvae and pupae were generally found in fresh or slightly brackish pools and backwaters near

the coast, on many occasions a remarkable concentration was found in canoes drawn up on the sea beach or banks of tidal creeks. In some instances the water contained in the canoes was fresh (according to a native attendant), but in others it was slightly to distinctly saline. In some cases (Moresby District) *Anopheles subpictus* Grassi were associated with *C. sitiens* in canoes containing fresh or slightly brackish water, but, as a rule, when the latter were very plentiful no other larvae were found. Larvae were found in small numbers on Yule Island in the more tranquil parts of a small grass-fringed running stream.

Localities: New Britain; New Guinea (Madang); New Ireland; Ninigo Island; Papua (Samarai, Mekeo and Moresby Districts); Woodlark Island.

Culex cataractarum Edwards.

Bull. Ent. Res. XIV., p. 7 (1923).

The specimens comprising the type series were collected upon a moss and fern-covered rock in a ravine.

Locality: New Britain (Rabaul).

Culex basicinctus Edwards.

Bull. Ent. Res. XII., p. 78 (1921) and XIII., p. 96 (1922).

(Pl. IX., Fig. 23 a-e.)

This species has been reared from a small rain pool on a rock in the Townsville District (Q.).

Culex squamosus Taylor.

Trans. Ent. Soc. 1913, p. 691 (1914) (*Culicada*).

This species has been bred by Dr. Heydon, from plantation drains in the Solomon Group.

Culex (Culiciomyia) muticus Edwards.

Bull. Ent. Res. XIV, p. 6 (1923).

(Pl. IX., Fig. 24 a-f.)

The type series, the larvae and pupae of which are figured here, were bred from a contaminated native well near the sea beach at Rabaul; it has been bred by Dr. Wallace from water contained in a horse-trough. The larval siphon, which is denuded in the specimen figured here, is very long and slender, measuring 1.76 mm. in length by 0.114 in diameter at the middle.

Localities: New Britain; New Ireland; Solomon Group.

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Apart from the collections made by the writer in Australia, New Britain and Papua, most of the material dealt with in this paper was collected by Dr. G. M. Heydon, in New Britain and

the Solomon Croup, by Dr. H. G. Wallace, in New Ireland and New Guinea (Madang), by Dr. Backhouse in Admiralty Islands, by Mr. J. Anderson in Woodlark Island, by Dr. Giblin in Samarai, by Dr. Strong and Mr. B. F. Hill in Papua, and Mr. J. Clark in South-West Australia. To the first-mentioned the writer is especially indebted for several recently described *Culicini*, and a large collection of *Anopheles*, with notes on their habits.

In nearly all cases the identifications of species have been made or confirmed by Mr. F. W. Edwards at the request of Dr. G. A. K. Marshall, Director of the Imperial Bureau of Entomology, whose assistance is gratefully acknowledged.

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EXPLANATION OF PLATES.

PLATE V.

Fig. 1.—*Anopheles annulipes* Walker.

- a. Palp and proboscis.
- b. hind-leg.
- f. } Wings.
- c. }
- d. }
- e. }

Fig 2.—*Anopheles amictus* Edwards.

- a. Palp, proboscis and wing (male).
- b. }
- c. } Palp, proboscis and wing (female).
- d. }
- e. fore-leg.
- f. hind-leg.

Fig. 3.—*Anopheles* ?? *amictus* Edwards.

- a. Palp, proboscis and wing.
- b. Palp and wing.
- c. Palp.
- d. Wing.
- e. Fore-leg.

Fig. 4—*Bironella gracilis* Theobald.

- a. Larva—head and thorax.
- b. „ posterior segments.
- c. „ comb of 8th segment.
- d. Pupa—paddles.
- e. „ trumpet.

Fig. 5—*Anopheles punctulatus* Dönitz.

- a. Larva—head.
- b. „ right shoulder hairs.
- c. Pupa—trumpet.
- d. Adult—proboscis and palp (male).
- e. „ proboscis and palp (female).

PLATE VI.

Fig. 6.—*Anopheles punctulatus*, var. *moluccensis* (Swell.).

- a. Wing, proboscis and palp.
- b. Wing.
- c. fore-leg.
- d. hind-leg.

Fig. 7.—*Anopheles subpietatus* Grassi.

- a. Palp (male).
- b. Palp and antenna (female).
- c. wing.

Fig. 8.—*Anopheles* sp. ? (from New Britain).

Larva—Head.

Fig. 9.—*Megarhinus inornatus* Walker.

- a. Larva—antenna.
- b. „ posterior segments.
- c. Pupa—posterior segments.
- d. „ trumpet.

Fig. 10.—*Rachionotomyia quasiornata* Taylor.

Larva—posterior segments.

Fig. 11.—*Mucidus alternans* Westwood.

- a. Larva—mandible.
- b. „ labial plate.
- c. Pupa—trumpet.
- d. „ paddles.

Fig. 12.—*Armigeres lacuum* Edwards.

- a. Larva—head.
- b. „ antenna.
- c. „ posterior segments.
- d. Pupa—trumpet.
- e. „ paddles.

PLATE VII.

Fig. 13.—*Aedes (Stegomyia) variegatus* (Dol.).

- a. Larva—posterior segments.
- b. „ antenna.
- c. Pupa—trumpet.
- d. „ paddles.

